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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HARALD KRAUS and MARTINE CLAES

Appeal 2010-007916
Application 10/588,766
Technology Center 1700

Before ROMULO H. DELMENDO, MICHAEL P. COLAIANNI, and GEORGE C. BEST, *Administrative Patent Judges*.

BEST, *Administrative Patent Judge.*

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134, Appellants seek reversal of the Examiner's final rejection of claims 3-5, 8, 11-15, and 17 of Application 10/588,766. We have jurisdiction under 35 U.S.C. § 6(b).

For the reasons set forth below, we AFFIRM.

Issue

Did the Examiner reversibly err by rejecting claims 3-5, 8, 11-15, and 17 as obvious over the combination of published U.S. Patent Application 2003/0235985 ("Christenson," Dec. 25, 2003) in view of U.S. Patent No. 5,032,217 ("Tanaka," issued July 16, 1991) further in view of published U.S. Patent Application 2003/0230549 ("Buchanan," Dec. 18, 2003).

We answer this question in the negative.

Background

The '766 application discloses and seeks to claim a method for etching materials with a high dielectric constant ("high-k materials") selectively in the presence of SiO_2.

High-k materials can be used in complementary metal oxide semiconductor ("CMOS") technology to reduce quantum tunneling effects in transistor gates compared to SiO_2 as a gate material. Christenson, ¶¶ 2-3. Hafnium oxide, HfO_2, and zirconium oxide, ZrO_2, are examples of high-k materials which would enable higher transistor operation speeds at lower voltages. *Id.* at ¶¶ 2-3, 22.

In a manufacturing process, the high-k material is deposited as a layer over a substrate. Spec. ¶ 4. To be useful in CMOS chips, therefore, the chip manufacturer must be able to selectively remove the high-k material from those portions of the chip where it is unwanted in the presence of other materials, such as SiO_2. *Id.* at ¶¶ 4-7, 39.

The '766 application discloses an etching process that can achieve high degrees of selectivity for the materials HfO_2 and ZrO_2. According to the '766 application, the necessary selectivity can be achieved by first subjecting the metal oxide to ion bombardment, *id.* at ¶ 6, and then using an etchant

comprising dilute hydrofluoric acid in an organic solvent such as an alcohol wherein the pH is adjusted to less than 3, *id.* at ¶ 7. The etchant is dispersed in a continuous stream at a rate that is sufficient to generate a mean etchant flow velocity parallel to the substrate's surface of at least 0.1 m/s. *Id.* at ¶¶ 10-12.

Claim 17, the only independent claim at issue, is representative.

> 17. A method of selective etching comprising:
>
> providing a first material on a substrate, wherein said first material is HfO_2 or ZrO_2, and said first material is pretreated with an energetic particle bombardment;
>
> providing a second material on the substrate; and
>
> selectively etching said first material with a selectivity of at least 2:1 towards said second material by dispensing a liquid etchant onto the substrate surface and *generating a flow having a mean velocity v parallel to the surface of the substrate of at least 0.1 m/s,*
>
> wherein said liquid etchant is dispensed in a continuous flow as a free beam or as a liquid stream onto the substrate and spreads over the surface of the substrate.

(emphasis added).

Discussion

Appellants argue that there are two defects with the Examiner's rejection: (1) Christenson does not teach that the flow velocity parallel to the substrate surface is a result effective variable that can be optimized, and (2) Christenson teaches away from using HfO_2 or ZrO_2. Br. 3.

Although we will address these arguments individually, they suffer from a common defect. Both arguments are premised on the notion that one can attack an obviousness determination that uses a combination of

references by attacking one reference individually. This is incorrect. "Nonobviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references." *In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986); *see also In re Keller*, 642 F.2d 413, 425-26 (CCPA 1981).

I. The prior art taken as a whole teaches the velocity limitation

Appellants argue that the prior art does not teach any method of dispensing the etchant that results in the claim 17 requirement of "a flow having a mean velocity v parallel to the surface of the substrate of at least 0.1 m/s." Br. 3-6. *First*, Appellants argue that Christenson does not suggest that etchant flow velocity parallel to the substrate surface is a variable that could be optimized. Br. 4-5. *Second*, Appellants argue that Christenson does not teach a continuous flow of etchant parallel to the substrate surface. Br. 5-6.

Neither of Appellants' arguments is sufficient to overcome the Examiner's rejections. While Christenson does not specify a particular flow rate across the substrate surface, it does teach that etchant flow rates need to be optimized for the particular type of processor that is being used. As Appellants point out, in some of its examples Christenson uses a static bath of etchant solution. Br. 5 (citing Christenson ¶ 43). Other examples in Christenson use a centrifugal spray processor with high cross wafer flow rates. Christenson ¶ 55-62. From the similar results obtained in these disparate examples, Christenson draws the conclusion that etchant flow rate is not critical. *Id.* at ¶ 43. The rejection, however, is based upon the combination of Christenson, Buchanan, and Tanaka. Christenson teaches that etchant flow rates will have to be "selected based upon factors including

the type(s) of equipment being used." *Id.* Tanaka teaches the use of a single wafer centrifugal processor which supplies the etchant as a continuous stream onto a spinning wafer. Ans. 6. In such an apparatus, the etchant flows across the surface of the substrate, Tanaka Fig. 6; col. 4, l. 63-col. 5, l. 43, and necessarily has a velocity that is parallel to the substrate surface. In the experiments described in Tanaka, etchant was supplied with a flow velocity of 0.1 m/s. Ans. 6-7.

The prior art, therefore, taken as a whole, teaches the provision of a continuous stream of etchant with a velocity parallel to the substrate surface of at least 0.1 m/s.

II. The prior art taken as a whole teaches the use of HfO_2 and ZrO_2

Appellants argue that Christenson teaches away from the use of HfO_2 or ZrO_2. Br. 6-8. Christenson does state that "a material comprising only one elemental constituent other than oxygen (e.g., HfO_2 and ZrO_2), are [*sic*] highly resistant to dilute etchants." Christenson ¶ 22.

This argument, however, is based on the flawed premise that the obviousness rejection can be overcome by attacking Christenson rather than considering the teachings of all the references. Rather, the Christenson reference must be read for what it fairly teaches in combination with the prior art as a whole. *Merck*, 800 F.2d at 1097.

Read together and as a whole, the prior art teaches that HfO_2 and ZrO_2 are useful high-k materials. Christenson speculates that the reason that compounds like $Hf_{0.6}Si_{0.4}O_2$ can be etched by dilute HF solutions is that the inclusion of the silicon atoms disrupts the crystal lattice. Christenson ¶ 22. Buchanan teaches that bombardment of high-k materials renders them susceptible to etching with dilute HF. Buchanan ¶ 10. Indeed, Buchanan

notes that HfO_2 and ZrO_2 are preferred materials for use in its process. *Id.* at ¶ 30. Buchanan further suggests that the reason the bombardment renders the material susceptible to etching is that it disrupts the crystal lattice. *Id.* at ¶ 24. Thus it would have been obvious to supplement the etching process taught in Christenson with Buchanan's ion bombardment techniques in order to etch HfO2 or ZrO2 materials on the substrate.

Appellants' argument, therefore, is not sufficient to overcome the Examiner's rejections.

Conclusion

We have considered Appellants' arguments and do not find them convincing. We therefore sustain the Examiner's rejections of the claims under 35 U.S.C. § 103(a).

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv) (2011).

AFFIRMED.

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